

Client Name & No. Patent Corp. "09792494-5242"

Applicant Sonnenschein

Ser.# / Pat.# 09957,422 Due Date: 2/28/04

☐ U.S. national phase application based on PCT/IP

Please acknowledge receipt of:

- ☐ Application having \_\_\_ pages of specification and claims, and \_\_\_ sheets of drawings, FIG(S)
  - ☐ Declaration / Oath
  - ☐ Power of Attorney
  - ☐ Small Entity Statement
  - ☐ Check #
- ☐ Patent Assignment Cover Sheet
  - ☐ Assignment
  - ☐ Check #
- ☐ Letter Under 37 CFR §1.41(c)
- ☐ Information Disclosure Statement Form PTO-1449 & Refr.
- ☐ Certification
- ☐ Petition
- ☐ Check #

Mailed 2/24/04

- ☐ Preliminary Amendment
- ☐ Request for Priority and Pri. Doc.
- ☐ Reply to Office Action
- ☐ Request for Ext. of Time
- ☐ Check #
- ☐ Amendment After Final Rejection
- ☐ Request for Ext. of Time
- ☐ Check #
- ☐ Corrected Drawings
- ☐ Issue Fee Transmittal
- ☐ Check #

Other Patent & Trademark Agent

☒ Form 2038  
☒ Cert. of Mailing  
 Express Mail No. \_\_\_\_\_  
 By hpl



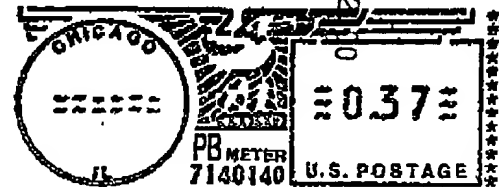
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CENTRAL FAX CENTER

NOV 09 2005

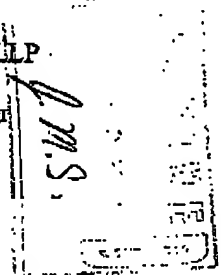
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OIPE/IAP

NOV 10 2005

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NOV 15 2005  
TECHNOLOGY CENTER 2



Sonnenschein, Nath & Rosenthal LLP  
 P.O.Box #061080  
 Wacker Drive Station, Sears Tower  
 Chicago, IL 60606-1080



BEST AVAILABLE COPY

07



IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

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PETITION TO WITHDRAW ABANDONMENT

NOV 09 2005

APPLICANT(S): Takayuki Fujioka, et al. ATTY. DOCKET NO.: 09792909-5242  
SERIAL NO.: 09/957,422 GROUP ART UNIT: 2871  
DATE FILED: September 20, 2001 EXAMINER: Unknown  
INVENTION: "DIFFUSING REFLECTOR AND MANUFACTURE OF THE SAME  
AND REFLECTION TYPE DISPLAY APPARATUS"

Mail Stop Petitions  
Commissioner for Patents  
P.O. Box 1450  
Alexandria, VA 22313-1450

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NOV 15 2005  
TECHNOLOGY CENTER 2800

S I R:

In response to the Notice of Abandonment dated January 30, 2004, Applicants petition for withdrawal of the abandonment as erroneous in light of timely filing of a proper response to the Notice to File Corrected Application Papers mailed on October 22, 2001. This Petition is being filed in accordance with 37 C.F.R. §1.181(a).

A Notice to File Corrected Application Papers was mailed on October 22, 2001, in the present application. The Notice set for a shortened statutory period for response, set to expire two months from the mailing date of the Notice.

On November 13, 2001, a Response to Notice to File Corrected Application Papers together with transmittal sheet, a \$130.00, and a self-addressed post card receipt were filed by Certificate of Mailing, copies of which are enclosed.

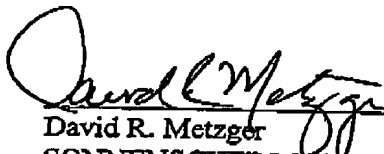
It is noted that this response was filed during the time period that the USPTO and the U.S. Postal Service instituted procedures for decontaminating incoming mail in view of the events surrounding the anthrax contamination of the U.S. postal facility used by the USPTO in Washington, D.C. In view of the fact that applicants cannot locate a stamped, return receipt postcard, applicants submit that it is highly likely that the Response and postcard were destroyed by the decontamination process. This occurred to many documents submitted by counsel during this time period.

Because applicants timely submitted a proper response to the Notice to File Corrected Application Papers, and because the events and procedures instituted in response to the 2001 anthrax contamination were beyond applicants' control, it is submitted that the abandonment was unavoidable.

Accordingly, it is submitted that the Response was timely filed and that withdrawal of the Notice of Abandonment is requested.

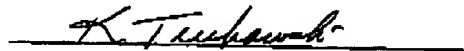
The Commissioner is authorized and requested to charge the amount of \$110.00 to cover the required petition fee to American Express Account No. 378571697401002.. Form 2038 is attached. However, a refund is requested if it is found that abandonment of the above application was, in fact, unavoidable and not the fault of applicants or their attorneys. FURTHER, IT IS BELIEVED THAT THIS PETITION IS COMPLIANT WITH THE PROCEDURES SET FORTH FOR DOCUMENTS NOT RECEIVED BY THE USPTO DURING THIS TIME PERIOD IN THE JANUARY 15, 2002, OFFICIAL GAZETTE (COPY ENCLOSED). Also, the Commissioner is authorized to charge any deficiencies or credit any overpayments to Deposit Account No. 19-3140. A duplicate copy of this sheet is enclosed for that purpose.

Respectfully submitted,

 (Reg. No. 32,919)  
David R. Metzger  
SONNENSCHNEN, NATH & ROSENTHAL  
P.O. Box 061080  
Wacker Drive Station - Sears Tower  
Chicago, IL 60606-1080  
Telephone 312/876-2578  
Customer #26263  
Attorneys for Applicant(s)

CERTIFICATE OF MAILING

I hereby certify that a true copy of the foregoing Submission of Missing Parts was forwarded to the United States Patent Office via U.S. First Class mail on February 24, 2004.





UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE  
United States Patent and Trademark Office  
Address: COMMISSIONER FOR PATENTS  
P.O. Box 1450  
Alexandria, Virginia 22313-1450  
www.uspto.gov

APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
09/957,422	09/20/2001	Takayuki Fujioka	9792909-5242

CONFIRMATION NO. 2711

ABANDONMENT/TERMINATION  
LETTER



\*OC000000011800432\*

26263  
SONNENSCHN NATH & ROSENTHAL LLP  
P.O. BOX 061080  
WACKER DRIVE STATION, SEARS TOWER  
CHICAGO, IL 60606-1080

Date Mailed: 01/30/2004

NOTICE OF ABANDONMENT UNDER 37 CFR 1.53 (f) OR (g)

The above-identified application is abandoned for failure to timely or properly reply to the Notice to File Missing Parts (Notice) mailed on 10/22/2001.

- No reply was received.

A petition to the Commissioner under 37 CFR 1.137 may be filed requesting that the application be revived.

Under 37 CFR 1.137(a), a petition requesting the application be revived on the grounds of **UNAVOIDABLE DELAY** must be filed promptly after the applicant becomes aware of the abandonment and such petition must be accompanied by: (1) an adequate showing of the cause of unavoidable delay; (2) the required reply to the above-identified Notice; (3) the petition fee set forth in 37 CFR 1.17(l); and (4) a terminal disclaimer if required by 37 CFR 1.137(d).

Under 37 CFR 1.137(b), a petition requesting the application be revived on the grounds of **UNINTENTIONAL DELAY** must be filed promptly after applicant becomes aware of the abandonment and such petition must be accompanied by: (1) a statement that the entire delay was unintentional; (2) the required reply to the above-identified Notice; (3) the petition fee set forth in 37 CFR 1.17(m); and (4) a terminal disclaimer if required by 37 CFR 1.137(d).

Any questions concerning petitions to revive should be directed to the "Office of Petitions" at (703) 305-9282. Petitions should be mailed to: Mail Stop Petitions, Commissioner for Patents, P.O. Box 1450, Alexandria VA 22313-1450.

*A copy of this notice **MUST** be returned with the reply.*

*D. D. Ousham*

Customer Service Center

Initial Patent Examination Division (703) 308-1202

PART 2 - COPY TO BE RETURNED WITH RESPONSE

RECEIVED  
NOV 15 2005  
TECHNOLOGY CENTER 2800

## United States Patent and Trademark Office OG Notices: 15 January 2002

### Processing of, and Requirements for, the Filing of Duplicate Applications and Papers in Patent Applications in view of USPS Mail Delays

Although mailed correspondence is being received by the United States Patent and Trademark Office (USPTO or Office), many papers that were mailed by first class mail or Express Mail through the United States Postal Service (USPS) in October and November of 2001 have had their delivery delayed. See Mitigation of Delays in Mail Deliveries to the USPTO, which is posted on the USPTO Internet Web site at: <http://www.uspto.gov/september11/mitigationofmaildelays.htm>. Some of those papers still have not been received by the USPTO. Although the USPS reports ([http://www.usps.com/news/2001/press/pr01\\_1023fact.htm](http://www.usps.com/news/2001/press/pr01_1023fact.htm)) that "98% of mail at the Brentwood facility has been sanitized and delivered," the USPS has also informed the USPTO that some of the mail that was in the Brentwood Mail facility on October 21 or 22, 2001 may never be received by the USPTO because of anthrax-related decontamination activities. Some applicants, concerned about papers mailed during this time period that have not been received by the USPTO, have filed duplicate copies of the original correspondence along with a statement that meets the requirement in 37 CFR 1.8(b)(3) prior to any holding of abandonment to permit the Office to more timely act on the correspondence. While Office processing of such duplicates will enable the examination process to move forward, applicants should be aware that the submission of duplicate copies may be unnecessary (and could slow down the processing of the application) and that double charging (collection) of the fees may result from subsequent processing by the Office of the delayed original, which may lead to the submission for, and the processing of, refund requests. The Office will try, however, to avoid double charging (collection) of fees as much as is possible.

#### I. Timeliness of Replies Whose Delivery to the Office has been Delayed:

In accordance with the Office's usual practice, if a paper was mailed with a certificate of mailing, the Office will determine the timeliness (e.g., 35 U.S.C. 133) of the paper based on the certificate of mailing date as set forth in 37 CFR 1.8(a). See Manual of Patent Examining Procedure (MPEP), Eighth Edition, 512, (August 2001). If a paper was sent by Express Mail, the Office will determine the timeliness and filing date of the paper based on the date of deposit with the USPS, which is the "date-in" on the Express Mail mailing label as set forth in 37 CFR 1.10(a). See MPEP 513. Therefore, if the procedures under 37 CFR 1.8 or 1.10 have been followed, any delays in delivery of the paper to the Office will not impact the timeliness of the paper. The Office will process a reply (whose delivery to the Office has been delayed) as timely if the date on the certificate of mailing, or the "date-in" on the Express Mail mailing label, is within the period for reply set forth in the prior Office action or notice.

#### II. Timeliness of Duplicate Replies Filed when the Original has not been Received by the Office:

A. If the duplicate is, itself, timely filed: If applicant submits a duplicate copy of a paper that has not been received in the Office, the duplicate paper will be processed by the Office as timely if the duplicate is filed within the period for reply to the prior Office action or notice (not considering any extensions of time that may have been available).

B. If a duplicate is filed after the expiration of reply

<http://www.uspto.gov/web/offices/com/sol/og/2002/week03/patdups.htm>

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original reply was timely mailed within the period from October 13, 2001 to December 1, 2001 using the certificate of mailing procedure under 37 CFR 1.8, and a duplicate copy is received in the Office after the period for reply has expired, then the Office shall accept the duplicate as the reply, and to have been timely filed, if applicant submits:

(1) a copy of the previously mailed reply and certificate of mailing of the previously mailed reply (the certificate of mailing must be signed and the certificate of mailing must itself indicate the date of mailing); and

(2) a statement that the reply was previously mailed to the USPTO on the date indicated on the certificate of mailing.

It is not sufficient to stamp the reply "Duplicate" or "Copy" and to fax the document to the USPTO, a statement is always required. The statement can be part of the fax transmittal cover sheet or the cover letter so long as the fax transmittal sheet is signed as specified below. The statement must be signed by: the person who personally mailed the original reply, a registered patent attorney or agent, the assignee of the entire interest, or the applicant (all of the inventors or the party qualified under 37 CFR 1.42, 1.43 or 1.47). For example, the statement may be: "This is a copy of correspondence that was mailed to the USPTO on \_\_\_\_\_ date" or "This is a copy of an amendment that was mailed to the USPTO on the date of the certificate of mailing."

If a certificate of mailing as set forth in 37 CFR 1.8 was not used (or if the certificate of mailing was not signed, or if the certificate of mailing did not include a date), and applicant does not have a post card receipt for the correspondence, the Office cannot accord the duplicate correspondence any date other than the date that the duplicate was actually received in the Office. If the duplicate copy was not itself timely filed, applicant should consider filing a petition to revive under 37 CFR 1.137(a) or (b).

To the extent that this treatment of showings as set forth 37 CFR 1.8(b) (3) is less stringent than the requirements set forth in 37 CFR 1.8(b)(3), the provisions of 37 CFR 1.8(b)(3) are hereby sua sponte waived for replies mailed on or after October 13, 2001 and no later than December 1, 2001.

### III. Establishing that a Paper other than a Reply was Mailed to the USPTO

A paper that is not a reply to an Office action or is not a correspondence that is required to be filed in the USPTO within a set period of time is NOT entitled to the benefit of a certificate of mailing under 37 CFR 1.8(a). The filing date of such a paper is the actual date of receipt in the USPTO, except as provided by 37 CFR 1.10. For example, a preliminary amendment is not a reply to an Office action and, therefore, would not receive the benefit of a certificate of mailing under 37 CFR 1.8(a). On the other hand, an information disclosure statement (IDS) will be considered to have been filed on the "date that it was received in the Office, or an earlier date of mailing if accompanied by a properly executed certificate of mailing." See MPEP 609, page 600-124. An IDS is entitled to the benefit of a certificate of mailing under 37 CFR 1.8(a) since the IDS is a correspondence that is required to be filed in the USPTO within a set period of time. To establish that a paper not entitled to the benefit of a certificate of mailing under 37 CFR 1.8(a) was filed in the USPTO, applicant must have used Express Mail and comply with the provisions of 37 CFR 1.10, or have a post card receipt establishing that the paper was actually received in the USPTO. Other than in these circumstances, the rules do not provide a mechanism for establishing

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#### IV. Office Will Try to Call Before Abandoning Applications Without a Reply.

In most circumstances, before holding an application to be abandoned, staff from the Technology Centers and the Office of Patent Publication will attempt to call applicants to see if a reply has been previously filed. If a reply has been filed, applicant will be requested to fax (or file) a duplicate copy of the prior (original) paper along with a showing as set forth in 37 CFR 1.8(b)(3) in order to avoid the application from being held abandoned.

If applicant files a duplicate with an acceptable showing as set forth in 37 CFR 1.8(b)(3), it will avoid both the Office holding the application as abandoned, and the processing delays associated with the withdrawal of such abandonment.

#### V. Duplicate Fee Charges (Collections) are Possible When Duplicates are Filed:

When the Office is processing a duplicate before processing the original, the Office shall charge (collect) all fees that are due for the proper processing of the paper, and will not process any papers that are not accompanied by the appropriate fee. Accordingly, applicants should expect that the same fees may inadvertently be charged (collected) when the Office later processes the original paper. The Office will try to avoid this type of double charging (collecting) by checking to see if the fees required to process a delayed original paper were previously charged (collected) and, if previously charged (collected), the Office will not charge (collect) the fees a second time. The Office, however, cannot guarantee that double charging (collecting) will not occur. If the Office processes fees with both the duplicate and then the original papers, applicant may request a refund under 37 CFR 1.26. If the application has been allowed, the refund request should be filed after the patent has been issued in order to avoid printing delays. When the original paper corresponding to the duplicate is received, the original paper will be attached to the duplicate in the application file wrapper and will not be listed as a separate contents entry for the application in the Office's records. This procedure will be used notwithstanding the procedure set forth in MPEP 719.01(a).

#### VI. How to File a Duplicate Reply during Examination or after Allowance:

A. If the Application is in a Technology Center: If applicant desires to file a duplicate copy of a reply to an Office action, with an appropriate showing as set forth in 37 CFR 1.8(b)(3), the duplicate should be faxed to the appropriate Technology Center. The reply facsimile numbers for each Technology Center that should be used are posted on the USPTO Internet web site at: <http://www.uspto.gov/september11/faxnotice.htm>.

B. If the Application has been Allowed: If applicant desires to file a duplicate Issue Fee transmittal (e.g., a duplicate PTOL-85B) in order to pay the issue fee and any publication fee, along with a duplicate copy of other post allowance correspondence that was submitted with the issue fee transmittal, accompanied by an appropriate showing as set forth 37 CFR 1.8(b)(3), the duplicate submission(s) and the showing(s) should be faxed to Box Issue Fee: (703) 746-4000. If an amendment under 37 CFR 1.312 was mailed before payment of the issue fee, and the Office has not yet received the amendment, applicant should include a copy of the amendment (and a statement explaining when the amendment was filed) with the issue fee payment so that the amendment under 37 CFR 1.312 is not treated as having been filed after payment of the issue fee, and therefore not entered (because amendments after payment of the issue fee are no longer

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# VII. Filing of Duplicate New Applications and Replies to OIPE:

The USPTO appreciates, that, where warranted, applicants should take advantage of 37 CFR 1.8(b) and 1.10(e), which permits the filing of duplicate copies of prior correspondence in place of lost or missing originals. While applicants should, as a general rule, promptly file a duplicate (of a new application filing or a reply to an OIPE notice) when they become aware that the Office has not received, and may not ever receive, an item of correspondence, the level of urgency usually associated with such action should take into account the fact that the USPTO expects to receive all, or substantially all, of the delayed correspondence. In addition, correspondence will be treated as filed (37 CFR 1.10) or timely (37 CFR 1.8), if applicant originally filed under those provisions regardless of the length of time that the correspondence took to reach the Office. In the event the Office has not received the original by March 1, 2002 applicant then should file a duplicate. The Office will mail a return post card receipt and/or filing receipt or notice, as it usually does, when correspondence is received by the Office so applicant will be informed when delayed correspondence has been received.

When the USPTO receives a duplicate submission, it shall consider a showing that a reply was timely mailed as set forth 37 CFR 1.8(b), or a petition for a filing date under 37 CFR 1.10(e), to have been timely filed so long as the showing or petition is filed by May of 2002. To the extent that this standard for timeliness is less stringent than the requirements set forth in 37 CFR 1.8(b)(1), 1.10(e)(1) and 1.181(f), the provisions of 37 CFR 1.8(b)(1), 1.10(e)(1) and 1.181(f) are hereby sua sponte waived for applications and papers mailed on or after October 13, 2001 and no later than December 1, 2001. Where there is a special need, however, applicants should take advantage of the rules and file duplicates without delay. Special needs could include the following: applications and correspondence mailed on or after October 17, and before October 23, 2001 that have not yet been received by the Office, Patent Cooperation Treaty application filings where priority has been claimed, design applications, replies to a Notice of Incomplete Application (filing date not granted) which was mailed under 37 CFR 1.8, and where certified copies of an application will be needed for priority purposes. In all other situations, before filing a duplicate of a prior mailed correspondence pursuant to 37 CFR 1.8(b) and 1.10(e), applicants might want to wait to see if the original is later received.

If correspondence sent via Express Mail was returned to applicant by the USPS, applicants should not file a duplicate, and should instead mail the original correspondence back to the USPTO as described in the notice "Suspension of the 'Express Mail' Service of United States Postal Service for mail addressed to ZIP Codes 202xx through 205xx" that is posted on the USPTO Internet Web site at: <http://www.uspto.gov/september11/uspsmaildisrup.htm>. Applicants who did not file an application using Express Mail may wish to consider filing a duplicate copy of the application via Express Mail, and not including the basic filing fee, or an authorization to charge the basic filing fee to a deposit account. When a duplicate application is submitted, applicant should anticipate that the duplicate (copy) application will be processed as a new application, any fees due will be attempted to be collected (as by either charging a deposit account if an authorization is given, or by mailing a Notice to File Missing Parts, requiring the filing fee(s)), and a filing receipt mailed. If the filing date accorded to the duplicate copy is an earlier filing date than that accorded the application that was previously mailed by first class mail, then applicant should respond to the Notice to File Missing Parts and pay

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PAGE 10/48 : RCVD AT 11/19/2005 10:08:10 AM [Eastern Standard Time] : SVR:USPTO-EFXRF-6/26 : DNIS:2738300 : CSID:312 876 7457 : DURATION(mm:ss):11-14  
first class mail is given a filing date before that of the duplicate, applicant need not reply to the Notice to File Missing Parts in the duplicate application, and can just prosecute the original application (thereby allowing the later-filed duplicate application to go abandoned).

When applicant mails a reply to a Notice from OIPE using a certificate of mailing, the reply will be considered to be timely so long as the certificate of mailing was dated before the due date set in the Notice, regardless of the length of time that it took to reach the USPTO. If the date of receipt of the correspondence was important, and applicant did not use Express Mail, and the response has not yet been received, applicant may wish to file a duplicate copy of the reply by Express Mail. An example of such a situation would be where a reply to a Notice of Omitted Items included a copy of a missing page of specification and requested a filing date of the date of receipt of the page of specification. The duplicate correspondence mailed to the Office pursuant to the Express Mail provisions of 37 CFR 1.10 will be given a filing date of the "date in" accorded by the USPS. If the duplicate is faxed to OIPE, the correspondence will be given a filing date as of the date of receipt, or if the actual date of receipt is a Saturday, Sunday or Federal Holiday, the next business day (see 37 CFR 1.6(a)(3)).

At the present time applications held in OIPE that are awaiting replies will not be processed as abandoned (if a reply could have been timely made during this period of delayed mail) and, therefore, calls requesting applicants to submit duplicate copies of replies to such notices will not generally be made. Calls to request such papers may be made for design applications.

#### VIII. Patent Term Adjustment:

Applications filed on or after May 29, 2000 may be eligible for patent term adjustment if issue of the patent has been delayed due to the failure of the Office to meet one of the time periods set forth in 35 U.S.C. 154(b)(1). See 35 U.S.C. 154(b). 37 CFR 1.703(f) provides that the date indicated on any certificate of mailing or transmission under 37 CFR 1.8 is not taken into account in a patent term adjustment calculation. If a reply to any Office action or notice is filed more than three months after the mailing date of the Office action or notice, the period between the date that is three months after the mailing date of the Office action or notice and the date of receipt (37 CFR 1.6) of the reply is considered a failure to engage in reasonable efforts to conclude prosecution, and any patent term adjustment to which the applicant would otherwise be entitled is required to be reduced by this period. See 35 U.S.C. 154(b)(2)(C)(ii) and 37 CFR 1.704(b). 35 U.S.C. 154(b)(3)(C) and 37 CFR 1.705(c), however, provide that an applicant may request reinstatement of all or part of the period of adjustment reduced pursuant to 35 U.S.C. 154(b)(2)(C) and 37 CFR 1.704(b) for failing to reply to an Office action or notice within three months of the date of mailing of the Office action or notice if the applicant provides a showing that, in spite of all due care, the applicant was unable to reply to the Office action or notice within three months of the date of mailing of the Office action or notice, but 35 U.S.C. 154(b)(3)(C) does not permit the Office to grant any request for reinstatement for more than three additional months for each reply beyond three months from the date of mailing of the Office action or notice.

If a reply to an Office action or notice was mailed on or after October 13, 2001 and no later than December 1, 2001 (as shown on a certificate of mailing under 37 CFR 1.8), and the applicant is otherwise entitled to patent term adjustment (or additional patent term

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adjustment under U.S.C. 154(b)(2)(C)(ii) and 37 CFR 1.704(b) due to the receipt of such reply by the Office more than three business days after the date indicated on the certificate of mailing, the Office will consider the USPS mail situation discussed in this notice to constitute a sufficient showing that, in spite of all due care, the applicant was unable to reply to the Office action or notice within three months of the date of mailing of the Office action or notice. In this situation, the Office will, subject to the conditions set forth below, reinstate a period equal to the period beginning on the date that is four business days after the date indicated on the certificate of mailing on the reply and the date of receipt (37 CFR 1.6) of the reply in the Office up to a maximum of three months.

If an applicant's request for reinstatement of patent term adjustment for the reason set forth above is the sole basis for requesting a change to the patent term adjustment indicated on the notice of allowance, the Office will waive the requirements of 37 CFR 1.705 (including fees) if the applicant submits a request for reinstatement of patent term meeting the following conditions:

(1) The request is submitted no later than the payment of the issue fee but no earlier than the date of mailing of the notice of allowance (unless the paper that was delayed in the mail was the issue fee payment or other paper submitted with or after payment of the issue fee, in which case the request must be submitted as soon as possible but no later than the day before the date of issue of the patent).

(2) The request is transmitted by facsimile to the Office of Petitions at (703) 308-6916.

(3) The request includes:

(a) a copy of the part of page with the certificate of mailing under 37 CFR 1.8 and a description of the paper (e.g., amendment, issue fee transmittal, notice of appeal);

(b) the date of receipt in the Office of the paper; and (c) the number of days requested to be reinstated as a result of the USPS mail situation discussed in this notice.

In addition, if applicant has access to the Patent Application Information Retrieval (PAIR) system, a copy of the PAIR contents records with the entry highlighted should also be included.

Applicants are again reminded that to maximize patent term adjustment they may wish to consider filing replies to Office actions: (1) under the "Express Mail" provisions of 37 CFR 1.10; (2) by facsimile; or (3) by hand-delivery. See Changes to Implement Patent Term Adjustment Under Twenty-Year Patent Term, 65 Fed. Reg. 56366, 56376 (Sept. 18, 2000), 1239 Off. Gaz. Pat. Office 14, 22-23 (Oct. 3, 2000) (final rule) (response to comment 10).

#### IX. Contact Information:

If you have a question relating to the status of a reply for an application in a Technology Center, please contact the Customer Service Representative of that Technology Center. If you have a question relating to the receipt of a new application or a reply for an application in OIPE, please contact the Customer Service Center in OIPE at (703) 308-1202. If you have a question relating to the receipt of post allowance correspondence, including issue and publication fee payments, please contact the Customer Service Center of the Office of Publications at (703) 305- 8283.

Questions concerning this notice should be directed to Darnell Jayne,  
<http://www.uspto.gov/web/offices/com/sol/og/2002/week03/patdups.htm>

2/24/2004

Legal Advisor, Office of Patent Legal Administration at (703) 308-6906.

December 20, 2001

ROBERT SPAR for  
STEPHEN G. KUNIN  
Deputy Commissioner for  
Patent Examination Policy

DOCKET NO. 9792909-5242

DVM/JVH

11/13/01

Patent Office Mail Room: Will you  
please affix the Patent Office stamp  
and return this card to acknowledge  
receipt of the following documents:

Applicant: T. Funioka, et al.  
Serial No.: 09/957,422  
Filing Date: September 20, 2001  
Client: Sony Corporation

Title: DIFFUSING REFLECTOR AND MANUFACTURE OF THE SAME AND  
REFLECTION TYPE DISPLAY APPARATUS

1. Transmittal Letter (1 page - in duplicate)
2. Response to Notice to File Corrected Application (1 page)
3. Substitute Specification (32 pages)
4. Copy of Notice to File Corrected Application Papers
5. Return Receipt Postcard

All mailed to the U.S. Patent and Trademark Office by First Class Mail on  
November 13, 2001

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant: T. Funioka, et al.

Serial No.: 09/957,422

Filed: September 20, 2001

For: DIFFUSING REFLECTOR AND  
MANUFACTURE OF THE SAME AND  
REFLECTION TYPE DISPLAY  
APPARATUS

Case No.: 9792909-5242

Group Art Unit: 2871

Examiner: not yet assigned

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Dear Sir:

Enclosed herewith is a Response to Notice to File Corrected Application Papers of T. Funioka, et al. in the above-identified patent application entitled DIFFUSING REFLECTOR AND MANUFACTURE OF THE SAME AND REFLECTION TYPE DISPLAY APPARATUS

Also enclosed are: Substitute Specification  
Copy of Notice to File Corrected Application Papers  
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Respectfully submitted,

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RESPONSE TO NOTICE TO FILE CORRECTED APPLICATION PAPERS

Box Patent Application  
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Dear Sir:

In response to the Notice to File Corrected Application Papers (Filing Date granted), dated October 22, 2001, in the above-identified patent application, applicants submit herewith a substitute specification in compliance with 37 CFR 1.52.

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APPLICATION NUMBER	FILING/RECEIPT DATE	FIRST NAMED APPLICANT	ATTORNEY DOCKET NUMBER
09/957,422	09/20/2001	Takayuki Fujioka	9792909-5242

CONFIRMATION NO. 2711

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FORMALITIES LETTER



\*OC000000006935427\*

Date Mailed: 10/22/2001

NOTICE TO FILE CORRECTED APPLICATION PAPERS

*Filing Date Granted*

This application has been accorded an Application Number and Filing Date. The application, however, is informal since it does not comply with the regulations for the reason(s) indicated below. Applicant is given **TWO MONTHS** from the date of this Notice within which to correct the informalities indicated below. Extensions of time may be obtained by filing a petition accompanied by the extension fee under the provisions of 37 CFR 1.136(a)

The required item(s) identified below must be timely submitted to avoid abandonment:

- A substitute specification in compliance with 37 CFR 1.52 because:
  - Papers contain improper margins. *Each sheet must have a left margin of at least 2.5 cm (1") and top, bottom and right margins of at least 2.0 cm (3/4")*

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## DIFFUSING REFLECTOR AND MANUFACTURE OF THE SAME AND REFLECTION TYPE DISPLAY APPARATUS

### BACKGROUND OF THE INVENTION

#### 1. Field of the Invention

The present invention relates to a diffusing reflector and method of manufacturing the same reflector and moreover a reflection type display apparatus utilizing the same diffusing reflector.

#### 2. Description of Related Art

A display apparatus utilizing a liquid crystal as an electro-optical layer is formed in the flat-panel shape characterized in thin and light weight structure assuring low power consumption. Therefore, such display apparatus has been developed for wide application field such as a display of hand-held devices. An electro-optical substance such as liquid crystal is not self light generating type and displays an image by selectively transmitting or shielding the external light beam. Such passive type display apparatus can be classified into the transmission type and reflection type depending on the lighting system.

In the transmission type display apparatus, a panel holding liquid crystal, for example, as the electro-optical layer between a couple of transparent substrates is produced



and a light source for lighting (backlight) is arranged at the rear surface of the panel and an image can be observed from the front side of panel. In the case of this transmission type, the backlight is essential and a fluorescent lamp, for example, is used as the light source. In the case of considering the display apparatus as a whole, since the backlight consumes the greater part of electrical power, it is not suitable for display of hand-held device. Meanwhile, in the case of the reflection type, a reflector is arranged at the rear surface of panel, while external light such as the natural light is incident to the front side and an image can also be observed from the front side by utilizing the reflected light thereof. Since the light source for lighting the rear surface is not used different from the transmission type, the reflection type display apparatus consumes less amount of electrical power in comparison with the transmission type and therefore it is suitable for display of a hand-held device.

In the reflection type display apparatus, display is realized by utilizing the incident light from the peripheral environment, it is essential to aim at improvement of brightness by effectively utilizing the incident light. Moreover, it is basically required to realize diffusing reflection of the incident light in the panel in order to

realize the white display called as so-called paper white. Therefore, the reflection type display apparatus of the related art comprises in many cases a diffusing reflection layer within the panel. This diffusing reflection layer has the surface including fine unevenness and also has the characteristic approximated to the perfect diffusion in order to show the external appearance of paper white as much as possible. However, it is difficult to conclude that the reflection characteristic is sufficient for practical use and it has been considered a problem of the reflection type display apparatus of the related art to improve the condition of unevenness from the stages of design and process in view of improving the reflection characteristic thereof.

#### SUMMARY OF THE INVENTION

The present invention is provided with the following means for solving the problems of the related art and attaining the objects. Namely, according to the present invention, a diffusing reflector can be produced by the following processes.

In the first process, a resin film having photosensitivity is formed on a substrate. In the next process, the resin film is patterned by the photolithography to provide a gathering of pillar-shaped bodies isolated each

other. Subsequently, in the next process, heat treatment is performed to allow gentle deformation of individual pillar-shaped bodies in order to form the layer having uneven surface with the maximum inclination angle under  $12^{\circ}$ . As the final process, a metal film is formed on the gently modified uneven layer. It is preferable to include the process in which the gently modified uneven surface layer is coated with resin to ease the maximum inclination angle by burying the flat opening between individual pillar-shaped bodies isolated each other. Preferably, individual pillar-shaped bodies are gently modified by conducting the heat treatment at the temperature of about  $220^{\circ}\text{C}$ . Preferably, the resin film is divided by the patterning through the photolithography to provide a gathering of polygonal pillar-shaped bodies isolated each other. It is also preferable that the resin film is divided by the patterning so that the size of gap between polygonal pillar-shaped bodies isolated each other becomes almost equal to the minimum resolution of the photolithography.

The present invention includes a structure itself of the diffusing reflector. Namely, the diffusing reflector of the present invention is composed of a resin film forming the heaping areas and a metal film formed on the surface of such heaping areas. Namely, the present invention is

characterized in that the heaping areas in which the maximum inclination angle is controlled under  $12^{\circ}$  are formed through reflow of the resin film composed of gathering of pillar-shaped bodies patterned each other previously leaving the opening between such pillar-shaped bodies.

The diffusing reflector produced by the method explained above can be comprised within the reflection type display apparatus. In this case, the reflection type display apparatus is provided, as the basic structure, with a first transparent substrate arranged in the incident side, a second substrate joined with the first substrate via the predetermined gap and is arranged in the opposite side, an electro-optical layer located in the first substrate side within the gap, a diffusing reflection layer located in the second substrate side within the gap and an electrode for impressing a voltage to the electro-optical layer formed in at least one substrate among the first and second substrates. The diffusing reflection layer is composed of a resin film forming the heaping areas and a metal film formed on the heaping areas. As the characteristic of such reflection type display apparatus, the heaping areas in which the maximum inclination angle is controlled under  $12^{\circ}$  is formed by reflow of the resin film consisting of gathering of pillar-shaped bodies divided through the patterning keeping

the predetermined opening between pillar-shaped bodies. Preferably, the gentle heaping areas are formed by reflow of resin film consisting of gathering of the pillar-shaped bodies and then burying the opening with the other resin film. It is preferable that the opening left after the reflow of the resin film consisting of gathering of pillar-shaped bodies is buried with the other resin to form the uneven surface having the gentle rolling. In the preferred embodiment of the reflection type display apparatus having such structure, a polarizing plate is arranged in the first substrate side and the liquid crystal layer which functions as the  $(1/4)$ -wavelength plate depending on the voltage impressing condition is used as the electro-optical layer. In this case, the  $(1/4)$ -wavelength plate is arranged between the polarizing plate and liquid crystal layer and the liquid crystal layer is composed of the nematic liquid crystal layer having positive dielectric anisotropy and the twisted alignment. This liquid crystal layer functions as the  $(1/4)$ -wavelength plate when a voltage is not applied and also loses the function of the  $(1/4)$ -wavelength plate when a voltage is applied.

According to the present invention, in view of improving the reflection characteristic of a diffusing reflector, the inclination angle of the layer having uneven

surface is optimized. Namely, the reflection characteristic of the diffusing reflector can be improved by controlling the maximum inclination angle to  $12^\circ$  or under. In general, when the maximum inclination angle becomes larger, angular distribution of reflected light beam is widened. When the maximum inclination angle is under  $12^\circ$  and particularly located near  $10^\circ$ , the diagonally incident external light increases in the element to be reflected to an observer located at the front side of apparatus. Therefore, it has been proved that bright image can be obtained. When the maximum inclination angle becomes larger than  $12^\circ$ , the element of reflected light totally reflected in the panel increases. Therefore such maximum inclination angle is not preferable.

#### BRIEF DESCRIPTION OF THE DRAWINGS

Figs. 1A to 1E are process diagrams illustrating a manufacturing method of the diffusion reflector of the present invention;

Fig. 2 is a plan view illustrating a pattern of gathering of pillar-shaped bodies formed on the diffusing reflector;

Fig. 3 is a schematic diagram illustrating a pattern design method illustrated in Fig. 2;

Fig. 4 is a graph showing distribution of inclination angle of the uneven surface layer of the diffusing reflector manufactured by the method of the present invention;

Fig. 5 is a schematic diagram illustrating a measuring system to simulate the reflection characteristic of the diffusing reflector manufactured by the present invention;

Fig. 6 is a graph showing the sine wave used in the simulation of the diffusing reflector of the present invention;

Fig. 7 is a graph showing the simulation result;

Fig. 8 is a graph showing the simulation result;

Fig. 9 is a graph showing the simulation result;

Fig. 10 is a graph showing the simulation result;

Fig. 11 is a graph showing the simulation result;

Fig. 12 is a schematic partial sectional view illustrating a preferred embodiment of the reflection type display apparatus comprising the diffusing reflector manufactured by the present invention; and

Fig. 13 is a diagram for explaining operations of the reflection type display apparatus illustrated in Fig. 12.

#### DESCRIPTION OF THE PREFERRED EMBODIMENTS

A preferred embodiment of the present invention will be explained in detail with reference to the accompanying

drawings. Figs. 1A to 1E are process diagrams illustrating a method of manufacturing a diffusing reflector of the present invention. As illustrated in Fig. 1A, a substrate 2, for example, consisting of glass material or the like is prepared. Next, as illustrated in Fig. 1B, a resin film 11 having photosensitivity is formed on the substrate 2. As a resin film 11, a photoresist, for example, may be used. In this embodiment, a film is formed in the thickness of about  $1.0 \mu\text{m}$  by coating of photoresist with the spin coating method. Next, in the process (1C), a gathering of pillar-shaped bodies isolated each other is provided by patterning the resin film 11 with the photolithography. In the photolithography method, exposing process is conducted through irradiation of ultraviolet ray and thereafter the developing process is performed. Adequate irradiation energy of ultraviolet ray is ranged from 150 mJ to 250 mJ. When irradiation energy is less than 150 mJ, the energy is too low and when it exceeds 250 mJ, the energy is too high, and thereby side etching may be generated. Subsequently, in the process (1D), individual pillar-shaped bodies are gently deformed through the heat treatment and thereby the layer having uneven surface having the maximum inclination angle under  $12^\circ$  may be formed. This reflow process is performed, for example, at about  $220^\circ\text{C}$ . Namely, the



pillar-shaped bodies are heated up to the temperature higher than the softening point or melting point of the resin film 11 and thereby the resin film 11 patterned on the pillar-shaped bodies is once fused and the pillar-shaped bodies are gently deformed through the effect of surface tension. Particularly, the upper end portion of the pillar-shaped body is gently deformed and the angular area is eliminated to provide the desired sloping surface. Moreover, the other resin layer 12 consisting, for example, of photoresist, is coated on the gently deformed uneven surface layer and the flat opening 2a between pillar-shaped bodies isolated each other is buried to ease the maximum inclination angle. Therefore, since the flat area is eliminated from the uneven surface layer formed on the surface of substrate 2, there is no fear for generation of mirror-surface reflection. Reflection brightness of the diffusing reflector observed from the front surface direction can be improved by suppressing mirror-surface reflection. This resin 12 is coated in the thickness, for example, of about 500 nm. This resin 12 should preferably have photo-sensitivity. When the resin 12 has the photosensitivity, the resin 12 may be patterned in the post-process and various processes may be performed when the diffusing reflector is comprised in the panel. Finally, in

the process (1E), the metal film 13 can be formed on the gently deformed uneven surface having the eased maximum inclination angle. Therefore, a diffusing layer 10 consisting of the resin film 11 and the metal film 13 laid over the resin film can be formed. The diffusing reflector 10 has a structure that a diffusing reflection layer 10 is formed on the substrate 2. The metal film 13 is formed by depositing a metal material, for example, such as aluminum, silver or the like on the substrate 2 by the sputtering or vacuum evaporation.

Fig. 2 is a schematic plan view illustrating pillar-shaped bodies isolated each other by patterning the resin film with the photolithography. In this embodiment, gathering of polygonal pillar-shaped bodies isolated each other by the divisional patterning of the resin with the photolithography is provided. The divisional patterning of resin film is conducted in such a manner that size of gap between the polygonal pillar-shaped bodies isolated each other becomes almost equal to the minimum resolution of photolithography. In order to improve reflection characteristic of the diffusing reflector, the pattern having uneven layer is important as well as the maximum inclination angle of the uneven surface layer. Namely, a pillar-shaped body having the uneven surface layer as the

unit shape of the diffusing reflector is determined in its shape by the mask pattern to be used for the photolithography. High density of uneven layer is essential for improvement of brightness of the diffusing reflector. Focusing on this point, the unit shape of the uneven surface layer to be depicted on the mask pattern is determined as polygonal shape in the present invention and thereby the uneven layer of the diffusing reflector is formed in higher density.

Fig. 3 is a schematic diagram illustrating an example of a mask pattern design method. As illustrated in the figure, circles in diameter of  $11\ \mu\text{m}$ , for example, are drawn to be in contact with each other. Next, boundaries of the circles in contact condition are connected continuously with straight lines and are then isolated each other. The isolated boundary width for isolation, namely the size of gap between neighboring polygonal pillar-shaped bodies is set to about  $1\ \mu\text{m}$  which is almost equal to the minimum resolution of the photolithography process. Diameter of the basic circle is  $11\ \mu\text{m}$  in average and size of gap between the polygonal pillar-shaped bodies obtained is  $1\ \mu\text{m}$ . Even when the density of mask pattern is changed, rise of density of polygons results in, on the contrary, increase of the maximum inclination angle because the minimum value of the distance between the neighboring polygonal patterns is determined by

the resolution. In order to obtain the good reflection characteristic, it is essential to control the maximum inclination angle to a value under  $12^\circ$ . Particularly, the preferable angle is about  $10^\circ$ . It has been proved by experiments that the maximum inclination angle can be obtained by setting the diameter of unit circle to about  $11 \mu\text{m}$  and the size of gap between the neighboring polygons to  $1 \mu\text{m}$  which is almost equal to the minimum resolution of the photolithography.

Optimization of the inclination angle of the uneven surface layer can be controlled not only by mask pattern design but also by the process. As explained above, the photoresist is coated by the spinning method in the thickness, for example, of  $1.0 \mu\text{m}$  and it is then exposed and then developed by the irradiation energy of 150 mJ or more using the mask illustrated in Fig. 2. Here, heat treatment is performed for an hour under the temperature of  $220^\circ\text{C}$  for the purpose of reflow. Thereafter, the resin consisting, for example, of photoresist is spin-coated in the thickness of about 500 nm. After the baking, metal aluminum or silver, for example, is sputtered in the thickness of 400 or 500 nm.

Angular distribution of the diffusing reflector obtained under the conditions explained above is shown in Fig. 4. The graph of Fig. 4 shows the distribution of

inclination angles of the uneven surface layers of a couple of samples indicated by black circle and black square. In any sample, the inclination angles are distributed under  $12^\circ$  and it can be understood that the maximum inclination angle of the uneven surface layer can be controlled to a value under  $12^\circ$ .

As explained above, according to the present invention, the maximum inclination angle of the uneven surface layer is controlled to the angle under  $12^\circ$  in order to improve the reflection characteristic of the diffusing reflector by improving manufacturing process and mask pattern. As will be explained below, the diffusing reflector just suitable for the reflection type display apparatus can be attained by controlling the maximum inclination angle to  $12^\circ$  or preferably to about  $10^\circ$ . It is an effect of simulation. Fig. 5 illustrates the direction of an observer set in the simulation. Considering the actual application environment, it is assumed that the external lighting beam is incident from the upper direction of panel in the incident angle of  $30^\circ$  for the normal line and an observer is looking at the panel 0 along the normal line. The panel 0 has a flat structure holding the liquid crystal layer 3, for example, as the electro-optical layer between a couple of substrates 1, 2.

As shown in Fig. 6, as a precondition of simulation, the sectional shape of the uneven surface of the diffusing reflector is approximated by the trigonometric function and its only one period is considered here. When wavelength of trigonometric function is kept constant and amplitude is changed, the differential coefficient reflecting the inclination angle is naturally varied and the maximum value of its absolute value can be obtained as  $\theta = 0.2\pi$ , for example, in the case of sine wave. It is assumed that the inside of panel is filled with liquid crystal, such inclination angle as not generating multiple-scattering is considered and moreover the incident angle of light is set to  $27^\circ$  or  $33^\circ$  corresponding to the actual light source of the measuring system. Here, reflection angle  $\theta_d$  observed from the normal line direction is considered in such a case that the light is incident to the uneven pattern of which sectional view is indicated by the sine wave as shown in Fig. 6. A profile of the sectional view of the uneven surface is defined, for example, as  $f(x) = R \cdot \sin 2\pi x$ . When considering refraction of the liquid crystal layer, it is enough to process the incident angle  $\theta$  in of the lighting beam in the range of  $\pm 42^\circ$  for the normal line direction and the amplitude condition for such range can be attained as  $R = 0.177$  or less by the brief calculation. The reflection angle

$\theta_d$  in this system is given as  $\theta_d = \pi/2 - \theta_{in} + \arctan(2 \pi R \cdot \cos 2 \pi x)$ . Here,  $x$  changes in the range from 0 to 1.  $x$  is plotted in the graduation of 0.01 and the incident angle range of incident light beam is taken in the range from  $68.7^\circ$  to  $72.4^\circ$ , considering the refraction of liquid crystal. The distribution of angle  $\theta_d$  (degree) when  $R$  is changed as a parameter under this condition is shown by the graphs of Fig. 7 to Fig. 11. In these graphs, the maximum inclination angle is indicted as a parameter in place of the value of  $R$  for easier understanding.

Fig. 7 shows the data of mirror-surface reflection. The distribution of reflection angle (Degree) shows the flat maximums between  $27^\circ$  and  $33^\circ$  indicating extremely stronger directivity. Fig. 8 shows distribution of reflection angle when the maximum inclination angle is  $5^\circ$ . Peaks are generated at the reflection angles of about  $15^\circ$  and  $45^\circ$ . Fig. 9 shows the data when the maximum inclination angle is  $7^\circ$ . The reflection angle is scattered to  $60^\circ$  from  $10^\circ$ . Fig. 10 shows the data when the maximum inclination angle is  $10^\circ$  and the higher peak is appearing at the reflection angle of  $0^\circ$ . Namely, the diagonal incident light deviated from the normal line direction is reflected in the direction of front surface to reach an observer. Thereby, bright display can be obtained. Fig. 11 shows the data when the maximum

inclination angle is  $12^\circ$ . As is apparent from the above graphs, when the maximum inclination angle becomes larger, angular distribution of the reflected light is widened, but these graphs suggest that when the maximum inclination angle is  $10^\circ$ , the light beam is reflected most effectively toward an observer. When the maximum inclination angle is  $12^\circ$  or larger, a large amount of light beam is reflected totally at the boundary of the substrate 1 in the opposite side and the liquid crystal layer 3. Based on the above simulation, the maximum inclination angle of the uneven surface layer of the present invention is set under  $12^\circ$  and preferably to the angle of about  $10^\circ$ .

Fig. 12 is a schematic partial sectional view illustrating a practical example of the reflection type display apparatus of the present invention. In this example, TN-ECB (Twist Nematic-Electrically Controlled Birefringence) mode liquid crystal panel 0 is used. As is illustrated, a polarizing plate 70, for example, of polymer film having optical anisotropy and a  $(1/4)$ -wavelength plate 80 are arranged at the surface of the panel 0 of the reflection type display apparatus of the present invention. The panel 0 is formed by joining a first substrate 1 consisting, for example, of the transparent glass plate located at the incident side of the external light beam and a second



substrate 2, for example, consisting of glass plate located at the opposite side via the predetermined gap. At the gap between both substrates 1, 2, the nematic liquid crystal layer 3, for example, is held as the electro-optical layer. The liquid crystal molecules 4 are provided under the twisted alignment by the upper and lower alignment films (not illustrated), for example, consisting of polyimide. Electrodes consisting, for example, of ITO are respectively formed at the internal surfaces of the substrates 1, 2 to apply the voltage to the nematic liquid crystal layer 3 in every pixel. This embodiment is so-called an active matrix type in which an opposite electrode 7 is formed in the side of the first substrate 1, while a pixel electrode (13) is formed in the side of the second substrate 2. The pixel electrode is driven by a switching element consisting of a thin film transistor 50 composed, for example, of polysilicon. The opposite electrode 7 and pixel electrode are provided opposed with each other, defining pixels between these electrodes. At the internal surface of the second substrate 2 located in the opposite side, the diffusing reflection layer 10 is formed depending on the present invention. The diffusing reflection layer 10 is composed of the stacked layer of resin films 11, 12 and metal film 13. In this embodiment, the metal film 12 is also working as the pixel

electrode. The reflection type display apparatus of the structure explained above is of the TN-ECB system in the normally white mode. Namely, when no voltage is applied, the nematic liquid crystal layer 3 functions as the (1/4)-wavelength plate by maintaining the twisted alignment and performs white display by allowing the external light beam to pass in cooperation with the polarizing plate 70 and the (1/4)-wavelength plate 80. When the voltage is applied, the nematic liquid crystal layer 3 shifts to the vertical alignment and loses the function as the (1/4)-wavelength plate and performs black display by shielding the external light beam in cooperation with the polarizing plate 70 and (1/4)-wavelength plate 80.

Subsequently, referring to Fig. 12, each structural element will be explained below. As is already explained above, a polarizing plate 70 is arranged at the surface of the first substrate 1 of the panel 0. Moreover, the (1/4)-wavelength plate 80 is also provided between the polarizing plate 70 and first substrate 1. This (1/4)-wavelength plate 80 is formed, for example, of a polymer film of which one axis is extended in order to give a phase difference as much as (1/4)-wavelength between the normal light beam and irregular light beam. An optical axis of the (1/4)-wavelength plate 80 is arranged to form the angle of

45° for the polarizing axis (transmitting axis) of the polarizing plate 70. The external light beam passes the polarizing plate 70 to become the linearly polarized light beam. The linearly polarized light beam passes the (1/4)-wavelength plate 80 to become the circularly polarized light beam. Moreover, when this light beam passes again the (1/4)-wavelength plate, it is converted to the linearly polarized light beam. In this case, polarizing direction is rotated for 90° from the original polarizing direction. As explained above, the (1/4)-wavelength plate can rotate the polarizing direction in combination with the polarizing plate and uses this process for the display function.

The panel 0 basically uses, as the electro-optical layer, the nematic liquid crystal layer 3 consisting of the nematic liquid crystal molecule 4 having horizontally aligned positive dielectric anisotropy. This nematic liquid crystal layer 3 functions as the (1/4)-wavelength plate by setting its thickness to adequate value. In this embodiment, the nematic liquid crystal layer 3 has the refractive index anisotropy  $\Delta n$  of about 0.7 and thickness of the nematic liquid crystal layer 3 is about  $3\mu\text{m}$ . Therefore, retardation  $\Delta n \cdot d$  of the nematic liquid crystal layer 3 becomes 0.2 to  $0.25\mu\text{m}$ . As is illustrated in the figure, since the nematic liquid crystal molecule 4 is provided

through the twisted alignment, a substantial value of the retardation becomes about  $0.15\mu\text{m}$  (150 nm). This value is almost equal to  $1/4$  of the center wavelength (about 600 nm) of the external light beam and thereby the nematic liquid crystal layer 3 is capable of optically functioning as the  $(1/4)$ -wavelength plate. The wanted twisted alignment can be attained by holding the nematic liquid crystal layer 3 with the upper and lower alignment films. In the side of the first substrate 1, the liquid crystal molecule 4 is provided on the line along the rubbing direction of the aligned film and the liquid crystal molecule 4 is also provided on the line along the rubbing direction of the aligned film also in the side of the second substrate 2. The wanted twisted alignment can be attained by shifting the rubbing direction of the upper and lower aligned films as much as  $60^\circ$  to  $70^\circ$ .

A color filter 9 is formed in the side of the transparent first substrate 1 consisting, for example, of negative resist in which pigment is dispersed. Meanwhile, a diffusing reflection layer 10 is formed in the side of the second substrate located in the reflecting side. The diffusing reflection layer 10 is provided with the uneven surface layer having the light scattering characteristic. Therefore, this layer shows the external appearance of paper white and

accordingly not only it is suitable for display of background but also the viewing angle is widened to assure easy display and brightness of display increases in the wider viewing range. As is illustrated in the figure, the diffusing reflection layer 10 is composed of resin films 11, 12 forming gentle heaping areas and the metal film 13 formed on the surfaces thereof. As is explained previously, the metal film 13 is also working as the pixel electrode. The diffusion reflection layer 10 is formed conforming to the present invention and is provided with the uneven surface layer having the gentle heaping areas by the reflow of resin film 11 consisting of gathering of pillar-shaped bodies previously and discretely patterned leaving the opening. Moreover, the opening being left is buried with the other resin film 12 after the reflow of the resin film 11 consisting of the gathering of the pillar-shaped bodies. The maximum inclination angle of the uneven surface layer is controlled to the angle under  $12^{\circ}$ .

A thin film transistor 50 for driving the pixel electrode is integrated and formed on the surface of the second substrate 2. The thin film transistor 50 has a bottom gate structure in the stacking structure in which the gate electrode 51 consisting, for example, of Mo, double-layer gate insulating films 52, 53 consisting, for example, of  $\text{SiO}_2$ ,

and SiN, and semiconductor thin film 54 consisting, for example, of polycrystalline silicon are sequentially stacked from the lower side. The thin film transistor has the double-gate structure including a couple of gate electrodes 51. A channel area is provided in the area of the semiconductor thin film 54 located just on each gate electrode 51. Each channel area is protected by a stopper 55. An auxiliary capacitance 60 is also formed in the same layer structure as this thin film transistor 50. The thin film transistor 50 and auxiliary capacitance 60 having the structure explained above are covered with an interlayer insulating film 59 consisting, for example, of PSG. On the interlayer insulating film 59, a contact hole communicating with the source area and drain area of the thin film transistor is opened. On this interlayer insulating film 59, a wiring 57 consisting, for example, of Al is formed and is connected to the source area and drain area of the thin film transistor 50 via the contact hole. The wiring 57 is covered with the resin film 12 explained above. Moreover, the pixel electrode (13) explained above is patterned. The pixel electrode is electrically connected to the drain area of the thin film transistor 50 via the contact hole opened to the resin film 12 and the wiring 57.

Referring to Fig. 13, operations of the reflection type

display apparatus illustrated in Fig. 12 will be explained. In this figure, (OFF) indicates the condition in which a voltage is not applied and (ON), the condition in which a voltage is being applied. As illustrated in the condition (OFF), the reflection type display apparatus of the present invention is formed by sequentially stacking the polarizing plate 70, (1/4)-wavelength plate 80, nematic liquid crystal layer 3 and diffusing reflection layer 10 from the observer side. The polarizing axis (transmission axis) of the polarizing plate 70 is defined as 70P. The optical axis 80S of the (1/4)-wavelength plate 80 is forming the angle of  $45^\circ$  for the transmission axis 70P. Moreover, the alignment direction 3R of the liquid crystal molecule 4 in the side of first substrate is parallel to the polarizing axis (transmission axis) 70P of the polarizing plate 70.

The incident light 201 is converted to the linearly polarized light 202 when it passes through the polarizing plate 70. The polarizing direction is parallel to the transmission axis 70P and such polarization is hereinafter called the parallel linear polarization. The parallel linearly polarized light 202 is then converted to the circularly polarized light 203 when it passes through the (1/4)-wavelength plate 80. The circularly polarized light 203 is then converted to the linearly polarized light when

it passes through the nematic liquid crystal layer 3 functioning as the  $(1/4)$ -wavelength plate. However, the polarizing direction of the linearly polarized light rotates for  $90^\circ$  to orthogonally cross the parallel linearly polarized light 202. Hereinafter, this polarization is hereinafter called the orthogonal linear polarization. The orthogonal linear polarized light 203 is reflected by the diffusing reflection layer 10 and passes again the nematic liquid crystal layer 3 functioning as the  $(1/4)$ -wavelength plate to become the circularly polarized light 204. The circularly polarized light 204 passes moreover the  $(1/4)$ -wavelength plate 80 and thereby it is converted to the original parallel linearly polarized beam 205. This parallel linearly polarized light 205 passes the polarizing plate 70 and then reaches the observer as the output light 206 resulting in white display.

In the condition (ON) where a voltage is being applied, the liquid crystal molecule 4 is shifted to the vertical alignment from the twisted alignment, losing the function as the  $(1/4)$ -wavelength plate. The external light 201 having passed the polarizing plate 70 is converted to the parallel linearly polarized light 202. The parallel linearly polarized light 202 is converted to the circularly polarized light 203 when it passes through the  $(1/4)$ -



wavelength plate 80. The circularly polarized light 203 passes in direct through the nematic liquid crystal layer 3 and is then reflected by the diffusing reflection layer 10 and then reaches the (1/4)-wavelength plate 80 as the circularly polarized light 204a. Here, the circularly polarized light 204a is converted to the orthogonal linearly polarized light 205a. The orthogonal linearly polarized light 205a cannot pass through the polarizing plate 70, resulting in black display.

According to the present invention, the diffusing reflector can be manufactured by the processes of forming a resin film having photosensitivity on a substrate, providing gathering of pillar-shaped bodies isolated each other by the patterning of resin film with photolithography, forming layer having the uneven surface with the maximum inclination angle under  $12^\circ$  by gently deforming individual pillar-shaped bodies through the heat treatment and forming a metal film on the gently deformed uneven surface layer. The reflection brightness observed from the front surface can be improved and the optimum design to improve display quality can be realized by comprising such diffusing reflector into the reflection type display apparatus.

WHAT IS CLAIMED IS:

1. Method of manufacturing a diffusing reflector comprising the processes of:
  - preparing for a substrate;
  - forming a resin film having photosensitivity on said substrate;
  - providing gathering of pillar-shaped bodies isolated each other through patterning of said resin film with the photolithography;
  - forming uneven surface layer having the maximum inclination angle of under  $12^{\circ}$  by gently deforming individual said pillar-shaped bodies through the reflow; and
  - forming a metal film on gathering of said gently deformed uneven surface layer.
2. Method of manufacturing a diffusing reflector as claimed in claim 1, wherein said maximum inclination angle is about  $10^{\circ}$ .
3. Method of manufacturing a diffusing reflector as claimed in claim 1, comprising a process of alleviating said maximum inclination angle by coating said gently deformed uneven surface layer with resin to bury the flat opening between said uneven surface layers isolated each other.
4. Method of manufacturing a diffusing reflector as claimed in claim 1, wherein said reflow process is the heat

treatment under the temperature of about 220°C.

5. Method of manufacturing a diffusing reflector as claimed in claim 1, wherein gathering of polygonal pillar-shaped bodies isolated each other by the divided patterning of said resin film by said photolithography is provided.

6. Method of manufacturing a diffusing reflector as claimed in claim 5, wherein said resin film is patterned by the divided patterning means so that size of gap between said polygonal pillar-shaped bodies isolated each other is almost equal to the minimum resolution of photolithography.

7. Diffusing reflector comprising:

substrate;

resin film forming heaping areas;

metal film formed on said resin film; wherein

said resin film forming heaping areas can be attained by reflow of gathering of pillar-shaped bodies previously isolated each other leaving openings through the patterning and the maximum inclination angle of said heating areas is controlled under 12°.

8. Diffusing reflector as claimed in claim 7, wherein said maximum inclination angle is about 10°.

9. Diffusing reflector as claimed in claim 7, wherein size of said opening of said pillar-shaped bodies is almost

equal to the minimum resolution of photolithography.

10. Diffusing reflector as claimed in claim 7, wherein gently heaped areas are formed by burying the gaps being left with the other resin film after reflow of said resin film consisting of gathering of pillar-shaped bodies.

11. Diffusing reflector as claimed in claim 7, wherein said reflow is the heat treatment under the temperature of about 220°C.

12. Diffusing reflector as claimed in claim 7, wherein the cross-sectional view of said resin film forming the heaping areas is a polygonal shape.

13. Reflection type display apparatus comprising:  
transparent first substrate to be arranged in the incident side;

second substrate to be coupled with said first substrate via the predetermined gap and arranged in the reflection side;

electro-optical layer located in said substrate side within said gap;

diffusing reflection layer located in the second substrate side within said gap; and

electrode formed at least one of said first substrate and second substrate for application of voltage to said electro-optical layer; wherein

said diffusing reflection layer is composed of a resin film forming heaping areas can be attained by the reflow of gathering of pillar-shaped bodies isolated each other previously patterned leaving openings and the maximum inclination angle of the heating areas is controlled under  $12^{\circ}$ .

14. Reflection type display apparatus as claimed in claim 13, wherein said maximum inclination angle is about  $10^{\circ}$ .

15. Reflection type display apparatus as claimed in claim 13, wherein size of said opening of said pillar-shaped bodies is almost equal to the minimum resolution of photolithography.

16. Reflection type display apparatus as claimed in claim 13, wherein gentle heaping areas are formed by conducting the reflow process to said resin film consisting of gathering of pillar-shaped bodies and then burying the openings being left with the other resin.

17. Reflection type display apparatus as claimed in claim 13, wherein said reflow process is the heat treatment under the temperature of about  $220^{\circ}\text{C}$ .

18. Reflection type display apparatus as claimed in claim 13, wherein cross-sectional view of said resin film forming the heaping areas is polygonal shape.

19. Reflection type display apparatus as claimed in claim 13, wherein a polarizing plate is provided in said first substrate side and a liquid crystal layer having the function as the  $(1/4)$ -wavelength plate depending on the voltage application condition is used as an electro-optical layer.

20. Reflection type display apparatus as claimed in claim 13, wherein a  $(1/4)$ -wavelength plate is provided between said polarizing plate and said liquid crystal layer said liquid crystal layer is composed of nematic liquid crystal layer having positive dielectric anisotropy and twisted alignment and also functions as the  $(1/4)$ -wavelength plate when a voltage is not applied or loses the function of the  $(1/4)$ -wavelength plate when a voltage is applied.

# ABSTRACT OF THE DISCLOSURE

There is provided a method of manufacturing a diffusing reflector which assures high diffusion efficiency and excellent reflection characteristic for the lighting.

First, a resin film having photosensitivity is formed on a substrate 2. Next, gathering of pillar-shaped bodies isolated each other by the patterning of resin film with the photolithography is provided. Subsequently, the uneven surface layer having the maximum inclination angle under  $12^{\circ}$  is formed by gently deforming individual pillar-shaped bodies with the heat treatment. Moreover, the gently deformed uneven surface layer is coated with the resin and the flat openings between pillar-shaped bodies arranged discretely are buried to ease the inclination angle. Finally, a metal film 13 formed on the gently deformed uneven surface layer.

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